

In this paper we describe a micro/nano satellite spacecraft and a supporting mission profile and architecture designed to enable preliminary in-situ characterization of a significant number of Near Earth Objects (NEOs) at reasonable cost. The spacecraft will be referred to as the NEO Scout. NEO Scout spacecraft are to be placed in GTO, GEO, or cis-lunar space as secondary payloads on launch vehicles headed for GTO or beyond and will begin their mission after deployment from the launcher. A distinguishing key feature of the NEO scout system is to design the mission timeline and spacecraft to rendezvous with and land on the target NEOs during close approach to the Earth-Moon system using low-thrust/high-impulse propulsion systems. Mission feasibility and preliminary design analysis are presented along with detailed trajectory calculations. The use of micro/nano satellites in low-cost interplanetary exploration is attracting increasing attention and is the subject of several annual workshops and published design studies (1-4).

The NEO population consists of those asteroids and short period comets orbiting the Sun with a perihelion of 1.3 astronomical units or less (5-8). As of July 30, 2013 10065 Near-Earth objects have been discovered. The spin rate, mass, density, surface physical (especially mechanical) properties, composition, and mineralogy of the vast majority of these objects are highly uncertain and the limited available telescopic remote sensing data imply a very diverse population (5-8). In-situ measurements by robotic spacecraft are urgently needed to provide the characterization data needed to support hardware and mission design for more ambitious human and robotic NEO operations.

Large numbers of NEOs move into close proximity with the Earth-Moon system every year (9). The JPL Near-Earth Object Human Space Flight Accessible Targets Study (NHATS) (10) has produced detailed mission profile and delta V requirements for various NEO missions ranging from 30 to 420 days in duration and assuming chemical propulsion. Similar studies have been reported assuming high power electric propulsion for manned NEO rendezvous missions (11). The delta V requirement breakdown and mission profile data from references 10 and 11 are used as a basis for sizing the NEO Scout spacecraft and for conducting preliminary feasibility assessments using the Tsiolkovsky rocket equation, a (worst-case) delta V requirement of 10 km/sec, and a maximum spacecraft dry mass of 20 kg. Using chemical propellant for a 10 km/sec delta V drives spacecraft wet mass well above 300 kg so that chemical propulsion is a non-starter for the proposed mission profile and spacecraft wet mass limits. In contrast, a solar electric propulsion system needs only 8 kg of Xe propellant to accelerate the spacecraft to 10 km/sec in 163 days with 0.02 N of thrust and 500 W of power from 1.6 m<sup>2</sup> of 29% efficient solar panels. In a second example, accelerating a 4 kg payload to 7 km/sec over 180 days requires about 6.7 kg of propellant and 1.2 kg of solar panels (12 kg total spacecraft wet mass).

## References

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